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(54) Method of forming orthodontic brace and orthodontic brace formed by such method.

(57) In a method of forming an orthodontic brace (10) calculations, preferably digital, on the contour and the desired positionings of the patient's teeth are made to determine the geometry (e.g. grooves) to be provided in brackets (12) for receiving an arch wire (14) to form an orthodontic brace. Such geometry is intended to provide for the disposition of the arched wire on the brackets (12) in a progressive curvature in a horizontal plane and a substantially linear configuration in a vertical plane. The geometry of the brackets (12) is altered (e.g. by cutting grooves (24) in the brackets (12) at individual positions and angles and with particular depths) in accordance with such calculations of the bracket geometry.

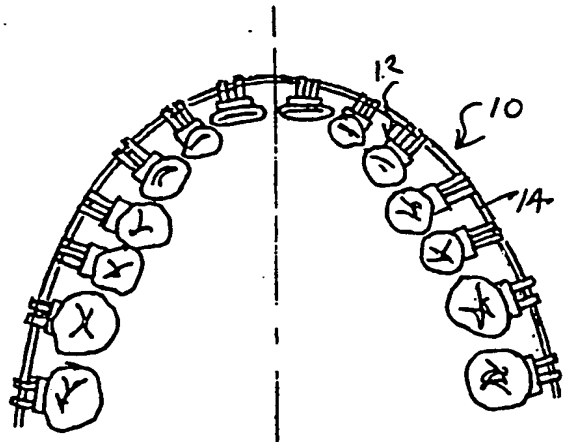

FIG. 9

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This invention relates to a method of forming an orthodontic brace from a plurality of brackets and an unbent arch wire such that the proper forces are applied by the brace to a patient's teeth to move the patient's teeth into a desired configuration. The invention also relates to an orthodontic brace with such properties.

When the teeth in a patient's mouth are displaced from an even or uniform disposition, such displacements tend to produce problems over an extended period of time. For example, such displacements may produce problems in the patient's gums. These problems may cause the retention of teeth by the patient's gums to become weakened so that the teeth become loose in the patient's mouth. The problem may become so aggravated that the teeth may eventually have to be removed from the patient's mouth.

To prevent the conditions in a patient's mouth from deteriorating, dentists often attempt to reset the positions of the teeth in the patient's mouth. The dentists do this by attaching braces to the patient's teeth and by gradually adjusting the forces applied by the braces to the teeth. These forces act against the teeth in the patient's mouth to move the teeth gradually toward the positions desired by the dentist.

The braces are generally formed by brackets and an arch wire supported in a groove in each of the brackets. Each bracket is adhered to an individual tooth by a pad forming a part of the bracket. The arch wire extends between the brackets on adjacent teeth and applies a force to the teeth to move the teeth toward the positions defined by the patient's orthodontist. Until now, the grooves on the different brackets have been substantially uniform. Because of this, the forces of the arch wire on the teeth have had to be adjusted by bending or otherwise distorting the wires.

The techniques discussed in the previous paragraph have had some beneficial effect. However, they are expensive and imperfect. One reason is that they require a considerable amount of work by the orthodontist to adjust progressively the forces applied against the teeth. Another reason is that the bending and distortion of the arch wire to adjust the forces on the different teeth have been largely on an empirical basis based in large part upon the experience of the orthodontist. As will be appreciated, even an experienced orthodontist is not able to bend or twist an arch wire precisely so that the proper force will be produced on the brackets attached to the individual teeth.

It has been appreciated in the art that it would be desirable to construct the brackets so that the arch wir is planar in an elevational view and is prograssively curved in a plan view even after attachment to the brackets and after the disposition in the patient's mouth of the brace formed by the brackets and the arch wire. For example, such a brace has been proposed in United States patent 3,477,128 issued to Lawrence F. Andrews on November 11, 1969 and United States patent 3,660,900 issued to Lawrence F. Andrews on May 9, 1972. In spite of the fact that such a brace has been proposed for such a long time and that considerable work has been performed on providing such a brace, no one has been able as yet to provide such a brace.

The proposals made by Andrews are based upon measurements made in a few skulls. They are not made on an individual basis for each patient. Furthermore, the proposals made by Andrews involve only a limited number of parameters. These parameters are mostly confined to individual characteristics of the grooves in the brackets. As will be appreciated, the proposals made by Andrews are quite crude and would not be sufficient to provide, for the unique parameters represented by the unique configuration and disposition of the teeth in a patient's mouth, a brace in which the arch wire is planar in an elevational view and is progressively curved in a plan view.

The Andrews patents are now twenty (20) years (in one case), or almost twenty (20) years (in the other case), old. In that period of time, no one has been able to advance the state of the art beyond the crude state proposed by Andrews. This is true even though a considerable effort has been made, and a significant amount of money has been expended, to advance the state of the art.

This invention provides a method of providing a brace which meets the criteria discussed in the previous paragraph. Specifically, in accordance with the method of this invention, a brace is provided which has a progressive curvature in a plan view plane and a substantially linear configuration in an elevational view and which exerts the proper forces on the teeth in a patient's mouth to move the teeth to a desired configuration predetermined by the patient's orthodontist. By providing such a brace, the method of this invention causes adjustments in the forces applied by the brace on the teeth in a patient's mouth to be minimized.

In one embodiment of the invention, a model of the teeth in a patient's mouth and a prescription of desired positionings of such teeth are provided by the patient's orthodontist. The contour of the teeth in the patient's mouth is determined, preferably digitally, from the model.

Calculations, preferably digital, on the contour and the desired positionings of the patient's teeth are then made to determine the geometry to be provided in brackets for receiving an arch wire to form an orthodontic brace. Such geometry is intended to provide for th disposition f the arched

wire on the brackets in a progressive curvature in a plan view and a substantially linear configuration in an elevational view. The g ometry of the brackets is altered in accordance with such calculations of the bracket geometry.

The geometry of the brackets may be altered in a number of different ways to provide the desired results. For example, the length, depth, width and positioning of the groove in the bracket may be individual to each bracket. Furthermore, if there are any rounded corners or curved surfaces to be provided in the grooves in each bracket, these are also determined on an individual basis. The height of each bracket and the angle of inclination of such bracket may also be individually determined. The width of each bracket and the curvature of the surface adhered on the bracket to the tooth may also be individually determined.

The brackets may be disposed on the model of the patient's teeth at positions dependent upon such calculations. A mold may be formed of the model of the patient's teeth and the brackets on such teeth. The model and the mold may be shipped to the orthodontist with written instructions for the disposition of the brace on the patient's teeth.

Alternatively, an information sheet may be prepared, after the calculation of the bracket geometry and the formation of the brackets, to specify the placement of the brackets on the patient's teeth and the disposition of the arch wire on such brackets. The brackets and the information sheet are sent to the orthodontist. The orthodontist is able, on the basis of the information in the sheet, to dispose the arch wire on the brackets to form the brace and to dispose the brace in the patient's mouth with the arch wire in a progressively curved disposition in a planar view and in a linear configuration in an elevational view.

In the drawings:

Figure 1 is a schematic flow chart of one embodiment of a method constituting this invention for forming a brace including an arch wire which is progressively curved in a plan view and is substantially linear in an elevational view;

Figure 2 is a schematic flow chart, in additional detail, of the method shown in Figure 1;

Figure 3 is a schematic view of equipment which may be used to perform one of the steps in the method shown in Figures 1 and 2;

Figure 4 is a schematic view of a tooth and illustrates how the equipment shown in Figure 3 performs the step in the method shown in Figures 1 and 2;

Figure 5 is a fragmentary schematic view of a brace formed from a plurality of brackets and an arch wire and schematically illustrates a pair of brackets and a portion of the arch wire in the brace;

Figures 6(a) through 6(e) are side elevational views illustrating how an individual bracket in the brace can be provided with different types of geometry in accordance with the method represented by the flow charts of Figures 1 and 2;

Figure 7(a) through 7(e) are top plan views further illustrating how an individual bracket in the brace can be provided with different types of geometry, other than those shown in Figures 6-(a) through 6(e), in accordance with the methods represented by the flow charts of Figures 1 and 2;

Figure 8 is a side elevational view schematically illustrating a plurality of teeth and the disposition on such teeth of a brace made in accordance with the method of this invention;

Figure 9 is a schematic plan view illustrating the disposition of the brace on the teeth in the patient's mouth;

Figures 10(a)-10(g) are side elevational views of brackets with different slot configurations;

Figures 11(a)-11(c) are front elevational views of brackets with different angles of the slots in the brackets; and

Figure 12 is a perspecrive view of a model of the positioning and configuration of the teeth in a patient's mouth before the teeth are reset to the positions predetermined by the patient's orthodontist.

The method of this invention provides an optimal formation of a brace generally indicated at 10 in Figures 8 and 9. The brace 10 includes brackets generally indicated at 12 and an arch wire 14 supported by the brackets. The arch wire 14 is disposed in an arched configuration having a progressive curvature when viewed on a plan basis (Figure 9) and having a linear configuration when viewed on an elevational basis (Figure 8). In this way, there are no discontinuities in the arch wire 14 when viewed either on a planar or an elevational basis.

Each bracket 12 includes a pad 16 and a support member 18 (Figure 6). The pads 16 and the support members 18 may be constructed in a manner disclosed and claimed in patent 4,068,399 issued to Frank R. Miller, Craig A. Andrieko and Kenneth R. Premo on January 17, 1978, and patent 4,165,561 issued to Frank R. Miller, Craig A. Andreiko and Kenneth R. Premo on August 28, 1979. The pads 16 and the support members 18 are made from a suitable material such as stainless steel. Stainless steel is desirable because it will not corrode in the patient's mouth. The pads 16 may preferably be in the form of a mesh.

Each of the pads 16 is bonded at one surface, as by an adhering glue 20, to the supporting member 16 and the other surface of the pad is bonded

to one of the patient's teeth. Alternatively, the bracket may be constructed with integral pad or bonding base. The support m mbers 18 are provided with grooves 24 in an outer surface 26 to receive the arch wire 14. The grooves 24 are provided with, lengths, depths, and widths, and are angled, to receive the arch wire 14 such that the arch wire exerts forces on the patient's teeth to move the teeth to a configuration predetermined by the patient's orthodontist. The different lengths and depths and angles the grooves 24 are schematically shown in Figures 10(a)-10(g). The different angles of the grooves 24 are schematically shown in Figures 11(a)-11(c).

To perform the method constituting this invention, a patient's orthodontist provides a model 30 (Figure 12) of the teeth in the patient's mouth as such teeth actually appear, from the standpoint of positioning and configuration, in the patient's mouth. This may be provided by having the patient bite into a plasticizable material to define a female mold. This mold is then used to form the model. The orthodontist also provides a prescription of a desired positioning and configuration of the teeth in the patient's mouth. The dentist supplies the mold and the prescription to a laboratory, which then performs the steps in the method of this invention.

The laboratory first determines the contour of each of the teeth in the model 30. This contour may constitute the thickness of the tooth at progressive positions in the vertical direction between the tip of the tooth and the patient's gum. The contour of each tooth in the model 30 may constitute a mesio-distal profile. This represents the thickness of each tooth at a median position between the opposite lateral ends of the tooth. Alternatively, additional contours may be determined for each tooth in the model at positions displaced from the median position. The contours are preferably determined on a digital basis to facilitate the processing of this information with other information determined in the laboratory.

Figure 3 illustrates apparatus, generally indicated at 40, for determining the contour of each tooth in the model 30, one of these teeth being illustrated schematically at 42 in Figure 4. As shown in Figure 3, the apparatus 30 includes a platform 44 for supporting the model 30 in a manner so that any selected tooth in the model 30 can rest on the platform. A probe 46 is supported on a stanchion 48 for movement in the vertical direction. The probe 46 is accordingly movable downwardly in Figure 3 to contact the tooth whose contour is being determined. This is indicated by an arrow 50 in Figure 3. The platform 44 is movable horizontally to probe the contour of this tooth at progressive positions on the tooth. This is indicated schematically by arrows 54 in Figure 3.

It will be appreciated that the apparatus shown in Figure 3 and described in the previous paragraph constitutes only one type of apparatus which may be used to determine the contour of the patient's teeth. For example, apparatus employing lasers, sonic elements or elements employing machine vision may also be used to determine the contour of the patient's teeth.

The prescription of the desired positionings and configuration of the patient's teeth are used to compute the geometry of the brackets. This information may relate to several different parameters. For example, the information may relate to various parameters defining the grooves 24 in the support members 18. These parameters may include the angle of the groove 24 in the support member 18, the lateral position of the groove in the outer surface 26, the width of the groove and the depth of the groove. The geometry of the groove 24 may also involve other parameters such as curvatures in the groove or configurations, other than linear, in the walls of the grooves to provide the brackets with the desired parameters.

The geometry of the brackets 12 may also involve other parameters such as variations in the distance between the surfaces 20 and 26 on the support member 18 in an elevational view. This is schematically shown in Figure 6(e). The minimum distance is shown in solid lines in Figure 6(e) and the maximum distance is shown in broken lines in Figure 6(a). The geometry of the brackets 12 may also involve additional parameters such as variations in the angle of the surface 20 relative to the surface 26 of the support member 18 on an elevational basis. Different angles of the surface 20 relative to the survace 26 of the support member 24 are schematically illustrated in Figures 6(b) and 6(d).

Other parameters involved in the geometry may be the width of each support member 18 to have the width correspond substantially to the width of the teeth to which the bracket including such support member is to be bonded. Furthermore, indicated in Figure 6(a) and by solid and broken lines in Figure 6(c), the pad 16 may be provided with a curvature in an elevational view corresponding to the curvature of the tooth to which the pad is to be bonded.

Figure 7 indicates how particular parameters of the brackets 12 may be varied in the plan view. For example, Figure 7(a) indicates how the thickness of the bracket may be varied in the plan direction. Figures 7(b) and 7(c) indicate examples in a plan view of different angles in the brackets 12. Figures 7(d) and 7(e) illustrate different curvatures of the brackets 12 in a plan view.

Figures 10(a)-10(g) illustrate different configurations of the brackets in elevation. For example,

Figures 10(a) and 10(b) illustrate different depths of the slot 24 in the bracket 12. Figures 10(c) and 10-(d) illustrate a diff rent height of the slot 24 than Figures 10(a) and 10(b) and further illustrate different depths of the slot for such different height. Figures 10(e)-10(g) illustrate different angles at which the slot 24 can be disposed in the bracket 12. Figures 11(a)-11(c) are front elevational views showing different angles of the slot 24 in the bracket 12.

The different parameters are provided with characteristics to provide the arch wire 14 with a progressive curvature in a plan view and a substantially linear configuration in an elevational view when the arch wire 14 is attached to the support members 18. The computations also indicate how the brackets 12 should be disposed on the patient's teeth from vertical, lateral and rotational standpoints.

It will be appreciated that the teeth in the patient's mouth may have some rebound after the arch wire 14 and the brackets 12 have been removed from the patient's mouth. It may accordingly be desirable to provide the arch wire 14 with a curvature representing some overshoot in the positioning of the patient's teeth beyond the optimal positioning of the teeth in the patient's mouth. This is considered to be within the scope of the invention. As used in the claims, the term "desired positioning of the teeth in a patient's mouth" is intended to include such an overshoot if the curvature of the arch wire 14 is designed to provide such an overshoot.

The computations discussed in the previous paragraph are then stored in a memory. The computations are also used to cut the grooves 24 in the support member 18 and to provide the support member and the pad 16 with the preferred geometry discussed in the previous paragraphs. In one embodiment of the method constituting this invention, the brackets are disposed on the teeth in the model in accordance with such computations and are adhered to the teeth on the model with a glue providing for a relatively easy removal of the brackets from the teeth. A female mold is then made of the model with the brackets properly positioned on the model.

The model with the brackets properly positioned on the teeth is then shipped to the orthodontist. An information sheet indicating the proper disposition of the brackets 12 on the teeth in the patient's mouth is also shipped to the orthodontist to instruct the orthodontist how to dispose the brackets 12 on the pati nt's teeth and how to install the arch wire 14 on the brackets. A duplicate information sheet may be retained by the laboratory for future reference. The female mold may also be shipped to the orthodontist. This may provide the orthodontist with an opportunity of making a female mold after the positioning of the brackets 12 on the teeth and comparing this female mold with the mold shipped to the dentist by the laboratory.

Alternatively, a map may be prepared by the laboratory. This may shows the proper disposition of the brackets on the teeth in the patient's mouth. The laboratory may ship this map, the brackets 12, the arch wire 14 and the information sheet to the orthodontist.

The method of this invention offers certain advantages over the prior art. It provides for the formation of brackets with proper geometry to provide for the disposition of the bracket properly on the teeth and the disposition of the arch wire in the brackets such that the arch wire has a progressive curvature in a plan view and a substantially linear configuration in an elevational view. Furthermore, the geometry of the brackets is such that the arch wire exerts a force on the teeth in the patient's mouth to move the teeth to a desired configuration prescribed by the orthodontist. The brackets are formed with the proper configuration automatically and without human intervention.

The brace 10 of this invention also has certain important advantages. It is formed on an individual basis for each patient to displace the teeth in that patient's mouth to a configuration and positioning prescribed by the patient's orthodontist. The brace 10 is formed on this individual basis by determining through calculations the geometry to be provided for the different brackets 12 in the brace. This geometry is such that the arch wire 14 has a progressive curvature in a plan view and a substantially linear disposition in an elevational view even after the arch wire is attached to the brackets.

It will be appreciated that the method of this invention may be used to form a brace only for a limited number of successive teeth in a patient's mouth. For example, the method of this invention may be used to form a brace only for the incisors or for the teeth between or including the bicuspids.

As will be appreciated, data processing systems are used in this invention to determine the contour of the teeth in the model on an individual basis. Software capable of being used to provide these calculations is attached to this application as Exhibit A and is considered to be a part of the specification. Data processing apparatus is also used to determine the geometry of the brackets 12. Such data processing processing equipment may include CAD/CAM systems now commercially available from a number of companies including Daisy Systems, Sun Microsystems and Apollo Computer (now a part of Hewlett-Parkard Company).

Although this invention has been disclosed and

illustrated with reference to particular embodiments, the principles involved ar susceptibl for use in numerous other embodiments which will be apparent to persons skilled in the art. The invention is, therefore, to be limited only as indicated by the scope of the appended claims.

Claims

1. A method of forming a dental orthodontic brace (10) from a plurality of brackets (12) each being adapted to be arranged at a tooth, and an arch wire (14) disposed in a progressive curvature in a plan view and a substantially linear configuration in an elevational view, including the steps of:

   calculating the geometry to be provided individually for each bracket (12) to receive the arch wire (14) in the progressive curvature in the plan view and the substantially linear configuration in the elevational view, such calculations being provided on the basis of parameters of the existing and the desired dispositions of the tooth in the patient's mouth, and

   providing the individual brackets (12) with the calculated parameters to receive the arch wire (14) in the progressive curvature in the plan view and the substantially linear configuration in the elevational view.

2. A method as set forth in claim 1 including the steps of:

   disposing the arch wire (14) on the brackets (12) in the progressive curvature in the plan view and in the substantially linear configuration in the elevational view in accordance with the parameters provided for the individual brackets (12).

3. A method as set forth in claims 1 or 2, wherein the calculated geometry is provided for each individual bracket (12) by cuting a groove (24) in such bracket (12) at a particular angle in the bracket (12) and to a particular depth in the bracket (12) and at a particular position in the bracket (12).

4. A method as set forth in any of claims 1 to 3 wherein the parameters of each tooth in the patient's mouth are determined from a model (30).

5. A method as set forth in any of claims 1 to 4 wherein said step of determining the parameters includ s d termining the thickness of the tooth at progressive positions on the tooth in vertical direction.

6. A method as set forth in any of claims 1 to 5 wherein said step of determining the parameters includes determining the contour of the tooth.

7. A method as set forth in any of claims 1 to 6 wherein the determinations of the parameters of the teeth in the patient's mouth are in a digital form,

   the prescription of the desired configuration of the teeth in the patient's mouth is in a digital form and

   the calculations of the optimal positions of the geometries of the brackets (12) in the patient's mouth are in a digital form.

8. A method as set forth in any of claims 1 to 7 including the step of controlling the operation of numerically controlled machinery (40), in accordance with the calculations of the geometries of the brackets (12), to provide the brackets (12) with such geometric parameters.

9. A method as set forth in any of claims 1 to 8 wherein the arched wire (14) is attached to the brackets (12) in accordance with the geometries provided in the brackets (12),

   the brackets (12) are attached to a model (30) of the teeth in the patient's mouth, and

   a mold is made of the model (30) of the teeth in the patient's mouth with the brackets (12) and the arch wire (14) on the teeth.

10. A method as set forth in any of claims 1 to 9, including the step of

    providing a map identifying the different brackets (12) and showing the placement of the brackets (12) on the patient's teeth.

11. An orthodontic brace (10) for dispostion in a patient's mouth to displace the teeth in the patient's mouth to a particular disposition and configuration, characterized by

    an arch wire (14),

    a plurality of brackets (12) each provided with particular geometries to retain the arch wire (14) in a progressive curvature in a plan view and in a substantially linear configuration in an

elevational vi w, each bracket (12) being formed from a support member (18) and a pad (16) adhered to the support member (18) and constructed to be adhered to an associated one of the teeth,

the geometries of each support member (18) and pad (16) including individual parameters for the length, width and depth of each groove (24) and the angle of the groove (24) in the support member (18) and further including the height of the support member (18), the angle between the adherence of the pad (16) to the support member (18) and the adherence of the pad (16) to the associated tooth and any curvature of the pad surface adhered to the associated tooth and the width of the support member (18).

12. An orthodontic brace as set forth in claim 11, including,

the arch wire (14) being disposed in the grooves (24) of the support members (18) and having a progressively curved configuration in a plan view and a linear configuration in an elevational view.

13. An orthodontic brace as set forth in claim 11 or 12, the geometries of the support member (18) being provided in accordance with the particular disposition and configuration of the teeth in the patient's mouth and the pads (16) being provided with configurations to conform to the contour of the associated teeth in the patient's mouth.

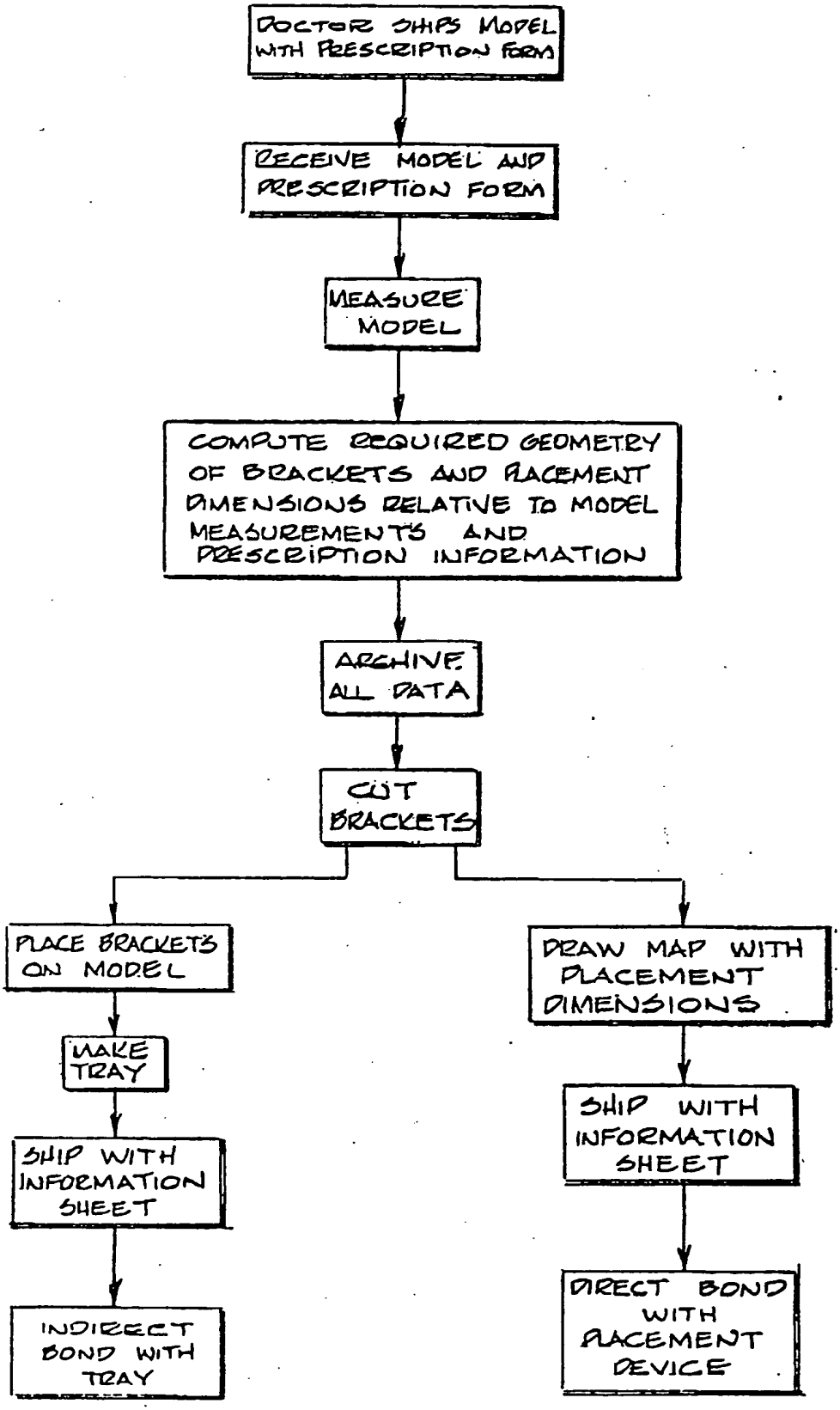

DOCTOR SHIPS MODEL WITH PRESCRIPTION FORM
RECEIVE MODEL AND PRESCRIPTION FORM
MEASURE MODEL
COMPUTE REQUIRED GEOMETRY OF BRACKETS AND PLACEMENT DIMENSIONS RELATIVE TO MODEL MEASUREMENTS AND PRESCRIPTION INFORMATION
ARCHIVE ALL DATA
CUT BRACKETS
PLACE BRACKETS ON MODEL
MAKE TRAY
SHIP WITH INFORMATION SHEET
INDIRECT BOND WITH TRAY
DRAW MAP WITH PLACEMENT DIMENSIONS
SHIP WITH INFORMATION SHEET
DIRECT BOND WITH PLACEMENT DEVICE

FIG. 1

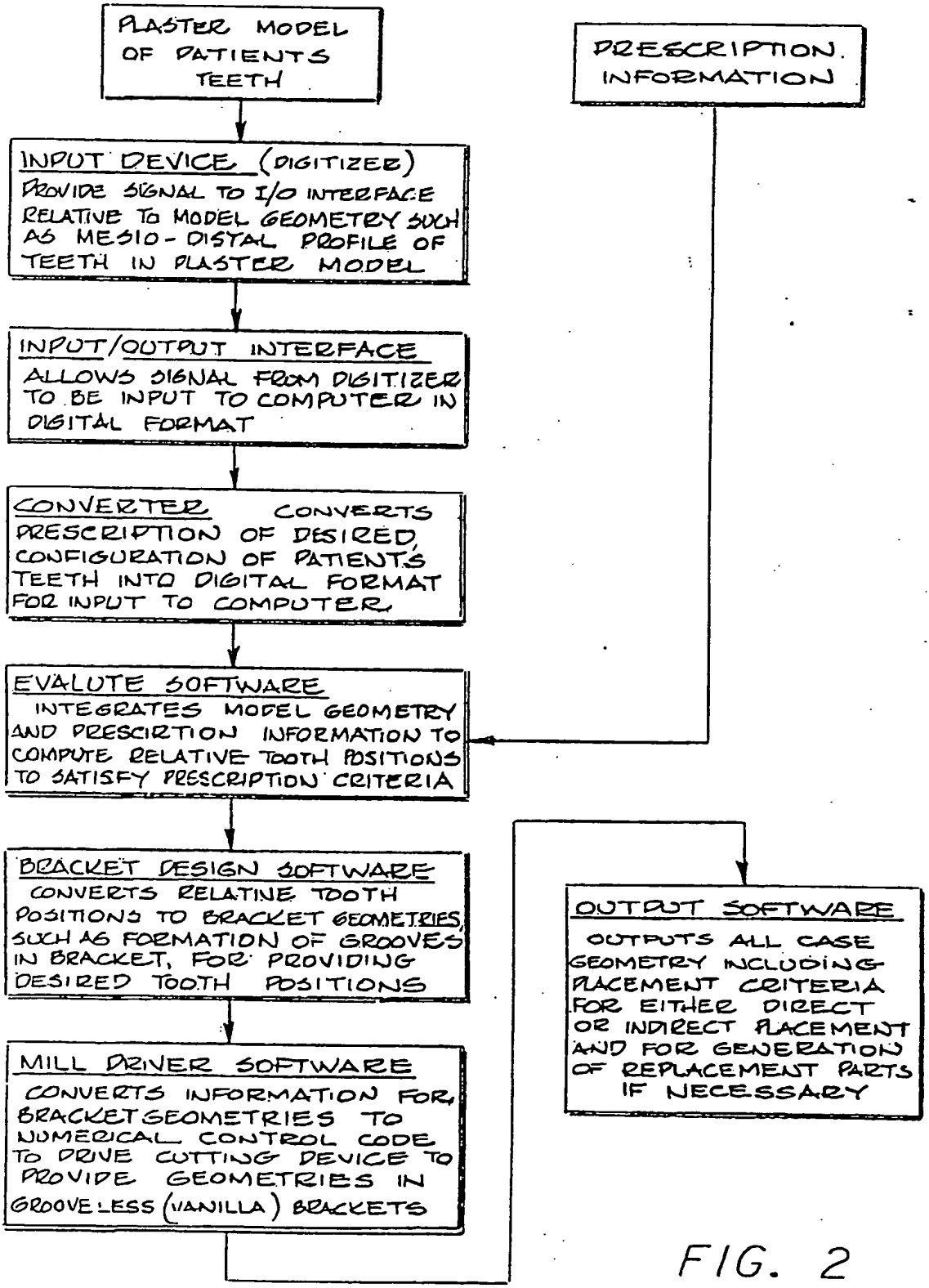

PLASTER MODEL OF PATIENTS TEETH
PRESCRIPTION INFORMATION
INPUT DEVICE (DIGITIZER)
PROVIDE SIGNAL TO I/O INTERFACE RELATIVE TO MODEL GEOMETRY SUCH AS MESIO-DISTAL PROFILE OF TEETH IN PLASTER MODEL
INPUT/OUTPUT INTERFACE
ALLOWS SIGNAL FROM DIGITIZER TO BE INPUT TO COMPUTER IN DIGITAL FORMAT
CONVERTER CONVERTS PRESCRIPTION OF DESIRED CONFIGURATION OF PATIENTS TEETH INTO DIGITAL FORMAT FOR INPUT TO COMPUTER
EVALUTE SOFTWARE
INTEGRATES MODEL GEOMETRY AND PRESCIRTION INFORMATION TO COMPUTE RELATIVE TOOTH POSITIONS TO SATISFY PRESCRIPTION CRITERIA
BRACKET DESIGN SOFTWARE
CONVERTS RELATINE TOOTH POSITIONS TO BRACKET GEOMETRIES SUCH AS FORMATION OF GROOVES IN BRACKET, FOR PROVIDING DESIRED TOOTH POSITIONS
MILL DRIVER SOFTWARE
CONVERTS INFORMATION FOR BRACKET GEOMETRIES TO NUMERICAL CONTROL CODE TO DRIVE CUTTING DEVICE TO PROVIDE GEOMETRIES IN GROOVELESS (VANILLA) BRACKETS
OUTPUT SOFTWARE
OUTPUTS ALL CASE GEOMETRY INCLUDING PLACEMENT CRITERIA FOR EITHER DIRECT OR INDIRECT PLACEMENT AND FOR GENERATION OF REPLACEMENT PARTS IF NECESSARY

FIG. 2

FIG. 3

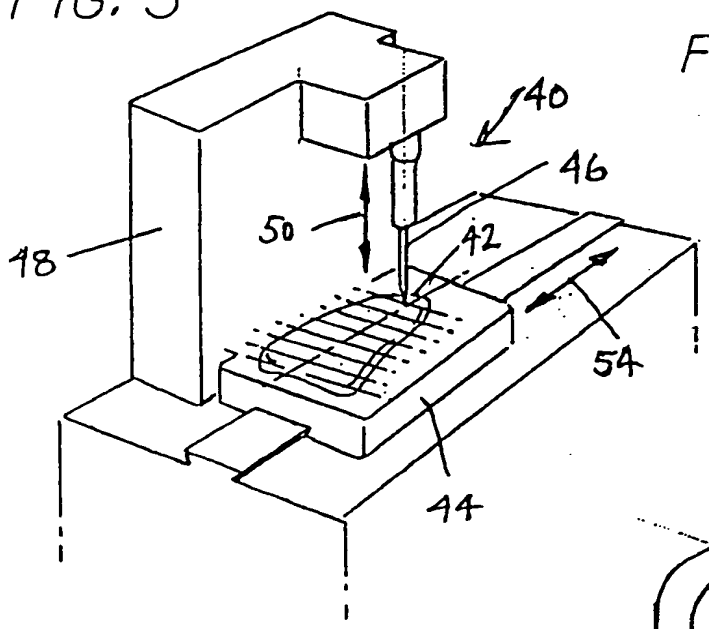
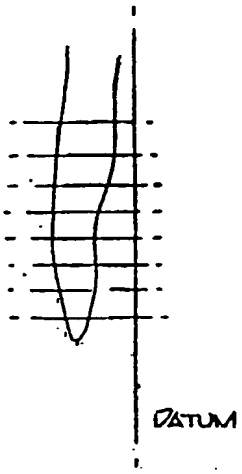


FIG. 4



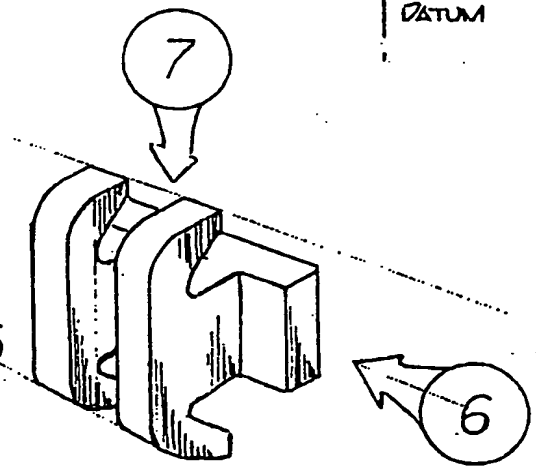


FIG. 5

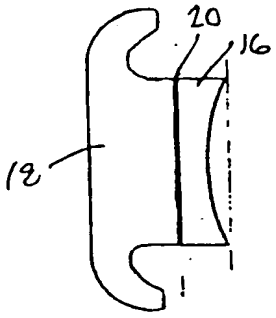


FIG. 6(a)

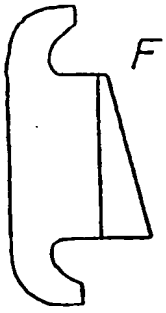


FIG. 6(b)

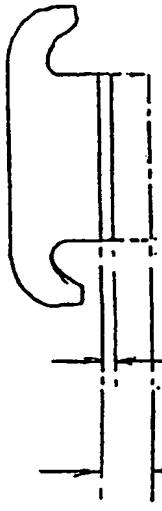


FIG 6(e)

FIG. 6(c)

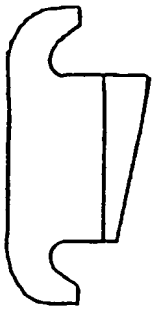


FIG. 6(d)

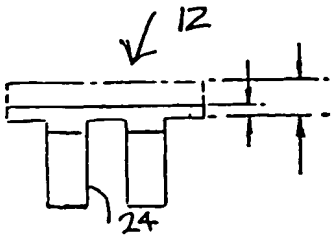


FIG 7(a)

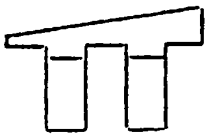


FIG 7(b)

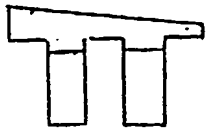


FIG 7(c)

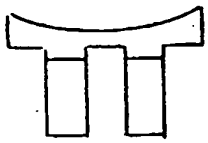


FIG 7(d)

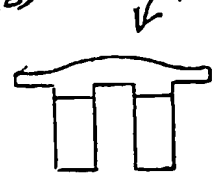


FIG 7(e)

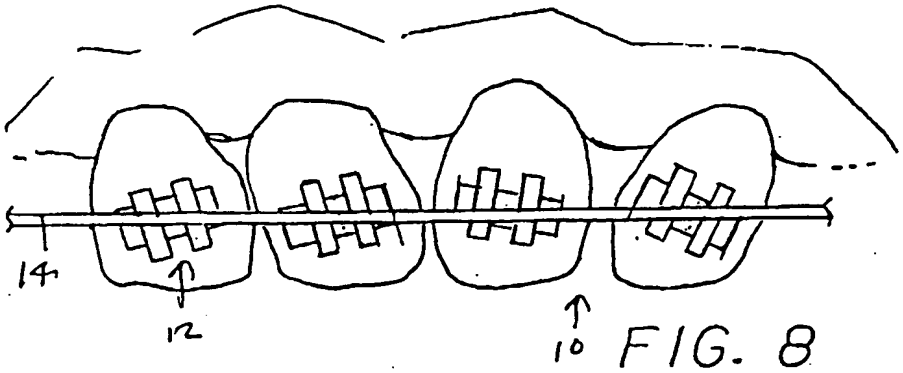


FIG. 8

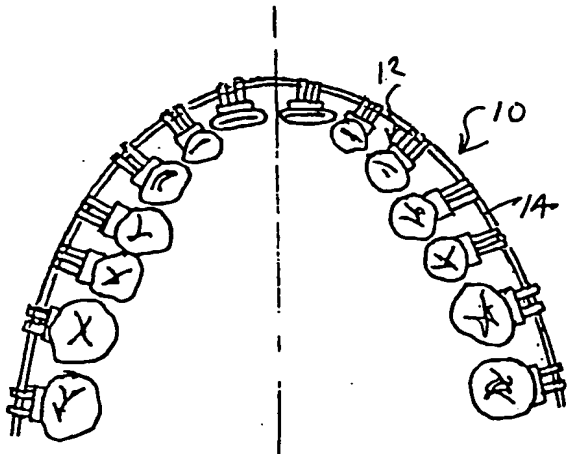


FIG. 9

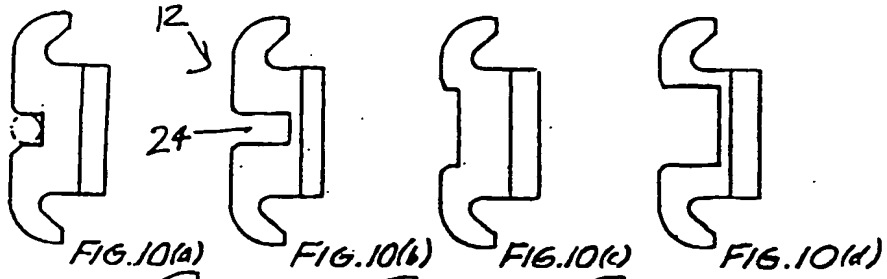


FIG.10(a) FIG.10(b) FIG.10(c) FIG.10(d)

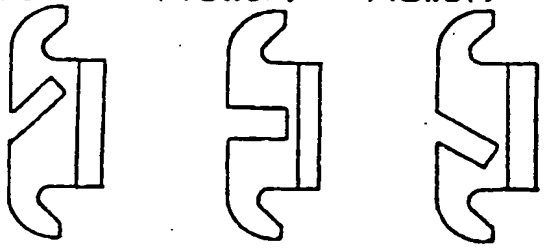


FIG. 10(e) FIG.10(f) FIG. 10(g)

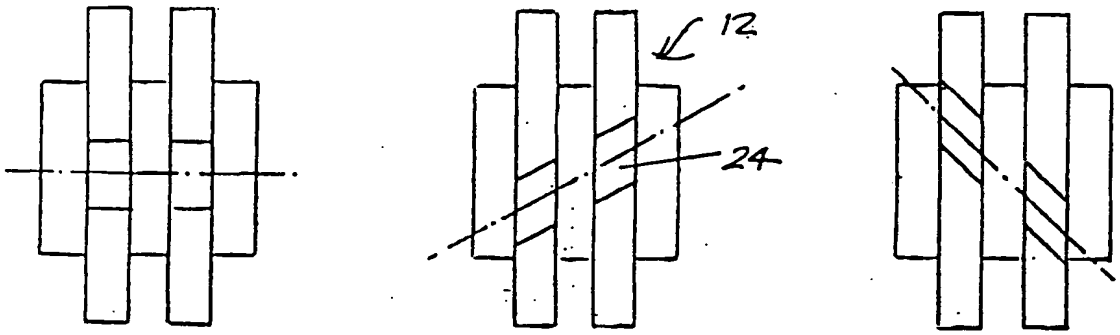


FIG. 11(a) FIG.11(b) FIG. 11(c)

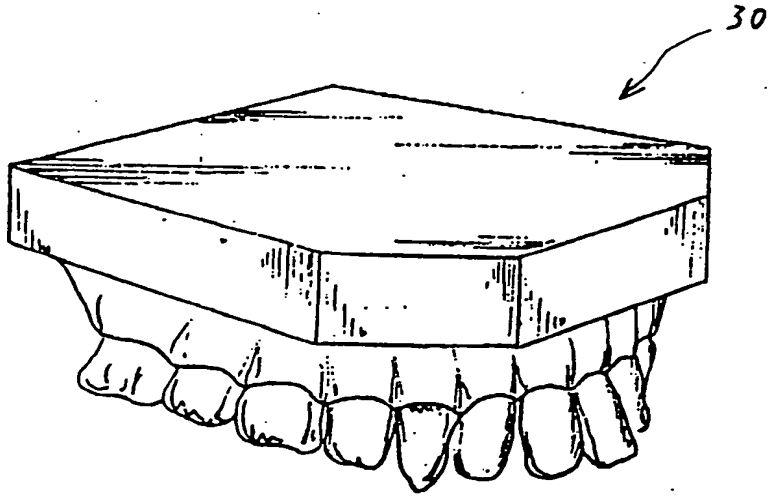


FIG. 12

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 91 10 3434

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X	WO-A-9 008 512 (DOLPHIN IMAGING SYSTEMS INC.) * the whole document *	1-13	A61C7/12
A	US-A-4 597 739 (ROSENBERG) * column 3, line 3 - line 11; figures *	1-6 11-13	
A	DE-A-2 600 380 (DELLINGER) * claims 1,6,10,11; figures *	1-3,8-13	
A,D	US-A-3 660 900 (ANDREWS)		

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

A61C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	29 OCTOBER 1991	PAUL CLARKSON

CATEGORY OF CITED DOCUMENTS

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